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NOTES FROM PACIFIC COAST OBSERVATORIES

A LIST OF NEW AND SUSPECTED DWARFS OF CLASS *M*

In the June Number of this journal Adams and Joy published a valuable list of dwarf M stars. In the course of an investigation of the spectra of faint stars with large proper motion, a number of new dwarf M stars was found and a list of 40 such objects is given here. Owing to the faintness of most of the objects a one prism spectrograph with short camera had to be used and even then exposures ranging up to 15 hours were sometimes necessary. On account of the small dispersion (6 mm from Hβ to K) the classification could not be very accurately carried out, but the presence of the band at 4957 A was usually sufficient to decide in favor of class M.

The results are collected in Table I. The first column contains the name of the star, an asterisk indicating that the classification rests on a rather poor plate. Next are given the apparent visual magnitude and the quantity $H=m+5+5\log\mu$. The fourth and fifth column give the position for 1900 and the last two columns the spectral subdivision and the absolute magnitude computed from trigonometric parallaxes. The bracketed values were derived from the quantities in the third column by the relations

$$M=10^{m}.0+0.57\,(H-15^{m}.9)\ \text{for class Ma}$$
$$\text{and}\ M=11^{m}.0+0.53\,(H-15^{m}.3)\ \text{for class Mb.}$$

These formulæ were derived from the data in Adams and Joy's list and from those stars in the present list for which a parallax is known. Accordingly these formulæ must be regarded as a better approximation than the one given in *Lick Bull.,* **10,** 135, 1922. The first formula gives a value for the absolute magnitude affected with a mean error of $0^{m}.72$.

TABLE I

Comp. to Bo 187 .	$10^{m}.7$	$18^{m}.0$	0^{h}	$12^{m}.7$	+43°	28′	Mb	$13^{m}.0$ [1]
B. D.+66° 34 . . .	9 .7	16 .0		26 .2	+66	42	Ma	(10 .1)
Wolf 33	11 .0	17 .0		45 .4	+57	45	Ma	10 .0

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[1] Bo 87. =*Groomb* 34, =*Lal.* 248.

B. D.+61° 195	11m.0	15m.3	0h	56m.3	+61°	48′	Ma	(9m.7)
B. D. +2° 348	10 .5	17 .6	2	07 .4	+ 3	10	Ma	(11 .0)
Comp. to Lpz II 961	11 .5	18 .6		30 .8	+ 6	25	Mb	12 .1
	10 .2	13 .8	3	02 .8	+45	22	Ma	(8 .8)
B. D. +17° 1320	9 .7	14 .4	6	31 .4	+17	38	Ma	10 .1
Wolf 294	10 .0	14 .5		48 .4	+33	24	Ma	(9 .2)
*Wolf 335	11 .2	16 .6	9	55 .1	+32	49	M	(10 .4)
Lpz II 6152	8 .8	14 .2	12	26 .3	+ 9	23	Ma	(9 .1)
Nic. 3469	8 .7	11 .7		45 .6	— 0	13	Ma	(7 .7)[2]
*Grw. Astr. +72° 6399	10 .8	15 .6	14	52 .0	+72	05	Ma	(9 .8)[3]
B. D.—7° 4003	9 .2	14 .8	15	14 .0	— 7	21	Ma	(9 .4)
Comp. to Chri 2448	10 .6	14 .1	16	16 .6	+67	30	M	11 .2
	10 .7	16 .2		21 .1	+48	36	Mb	11 .3
B. D. —12° 4523	9 .5	15 .0		24 .8	—12	18	Ma	(9 .5)
*Comp. to W Ott. 5811	11 .4	16 .9		49 .0	— 8	08	M	12 .3
*B. D. +25° 3173	9 .4	13 .0		54 .1	+25	55	Ma	(8 .4)[3]
26 Draconis C.	10 .5	15 .1	17	34 .0	+61	45	Ma	10 .0
B. D. +43° 2796	9 .5	13 .5		40 .9	+43	26	Ma	(8 .7)
Comp. to *μ Herculis*	9 .8	14 .1		42 .5	+27	47	Ma	10 .1[4]
Hels. 9945 B.	9 .4	16 .2	18	41 .7	+59	29	Mb	11 .7[5]
17 Lyræ C.	11 .3	17 .4	19	03 .7	+32	21	M	11 .7
	9 .4	12 .9	20	41 .5	+44	08	Ma	(8 .4)
Potsd. Astr. 1214, 608	9 .7	13 .8		56 .2	+39	41	Md.	9 .4[6]
B. D. +27° 4120	10 .4	13 .9	21	33 .5	+27	16	Ma	(8 .9)
C. P. D. —58° 7893	8 .6	13 .4		39 .4	—58	08	Ma	(8 .6)[7]
	10 .1	13 .7		49 .8	+41	19	Ma	(8 .7)[8]
B. D. +43° 4305	9 .5	14 .2	22	42 .5	+43	50	Md	(9 .1)
Wolf 1039	11 .4	17 .1	23	29 .2	— 0	21	Ma	9 .9
	10 .8	15 .1		30 .8	+41	25	Ma	(9 .5)
Comp. C. to Bo 18443	10 .2	14 .9		59 .9	+45	14	Ma	10 .2
Hels 6113	8 .5	12 .9	9	48 .8	+63	17	Ma	8 .3
Wolf 386	10 .5	15 .6	11	18 .6	+ 9	07	M	9 .9
B. D. +29° 2279	9 .5	14 .0	12	14 .5	+28	56	Ma	8 .9
B. D. +81° 465	9 .8	13 .6	14	10 .4	+80	51	Ma	8 .7
	10 .6	15 .3	17	16 .7	+41	50	Ma	9 .7
Wolf 1130	11 .4	17 .2	20	02 .8	+54	10	M	10 .7
Wolf 901	11 .4	16 .6		54 .1	+ 3	11	M	10 .4

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[2] H. D. No. 111631. Attention to this star was called by Dr. Lundmark.

[3] Titanium bands very weak.

[4] One of the faint components of the triple system μ Herculis has already been given by Adams. A plate taken with the slit parallel to the line joining the two faint stars, and without allowing them to drift shows that they both must have the same spectral class.

[5] The spectrum of the brighter companion has been given by Adams and Joy; in the Henry Draper Catalogue the spectra are given as K5 and Ma respectively.

[6] Bright hydrogen lines and extremely strong 4227.

[7] Spectrum from the Henry Draper Catalogue.

[8] The Iron line at λ 4528.8 A is the most conspicuous and is about 3 A wide.

[9] The distant companion to Bo 18443, Lal. 47231; its distance from the principal star is more than 3000 astronomical units.

Since, as has been emphasized by many investigators, the M dwarfs play an important role in stellar statistics, it may be of value to give a list of such objects for which the probability is high that they belong to Class M. As criteria may be taken the absolute magnitude (all absolute magnitudes below $+9^m.0$) and the color index or the effective wavelength together with the proper motion. Table II records 23 stars; its arrangement is identical with that of Table I except that the absolute magnitude is here given in the third instead of in the last column. On account of the extreme faintness of most of these stars, or their close proximity to bright stars it will be practically impossible with the present means to observe spectra for more than a few of them.

TABLE II

	$12^m.4$	$10^m.9$	2^h	$11^m.9$	+43°	49′[1]
Comp. to Hels. 2711	12 .6	11 .7		56 .5	+61	22[2]
Comp. to α *Tauri*	13 .5	12 .5	4	30 .2	+16	18
Comp. to Strb. 1493	12 .5	11 .6	5	14 .1	—3	11
Comp. to α *Ca. Min.*	13 .0	15 .5	7	34 .1	+5	29
Comp. to ρ_1 *Cancri*	13 .0	12 .6	8	46 .7	+28	42[3]
Comp. to θ *Urs. Maj.*	13 .7	13 .0	9	26 .2	+52	08
	13 .2	10 .6		35 .5	+56	27
	12 .8	14 .3	11	12 .0	—57	02
Comp. to Lpz I 4788	11 .8	9 .4	13	06 .4	+10	08
Comp. to Be. A. 4874	10 .1	9 .3		11 .9	+17	33
Comp. to Lund. 5723	11 .8	11 .1		14 .9	+35	39
Comp. to 374 G *Hydræ* . . .	13 .3	11 .1	14	13 .3	—25	22j
Proxima *Centauri*	10 .5	14 .9		22 .9	—62	15[4]
Comp. to 41 *Arae*	8 .4	9 .6	17	11 .5	—46	32
Comp. to 142 *Scorpii* (B) .	8 .1	9 .3		12 .2	—34	53
Comp. to 142 *Scorpii* (C) . .	10 .0	11 .2		12 .2	—34	53
Comp. to 26 *Drac.* (B) . . .	10 .6	10 .1		34 .0	+61	57
Comp. to 279 *Sagitt.*	11 .3	12 .7	20	04 .6	—36	21
C. D. —57° 8545	10 .5	(9 .7)	22	16 .9	—57	42[5]
Comp. to Hels. 13170	11 .3	13 .4		24 .4	+57	12[6]
Comp. to ζ *Pegasi*	12 .0	10 .9		41 .7	+11	40
Comp. to 85 *Pegasi*	11 .0	11 .0	23	57 .0	+26	33

To these 23 stars may still be added the following stars for which the value of $m+5+5 \log \mu$ exceeds $17^m.0$ (corresponding to absolute magnitude of $10^m.5$) and the majority of which therefore belong in all probability to Class M.

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[1] The color index, $+0^m.9$, was kindly communicated by Mr. van Biesbroeck.

[2] The color index was determined by Seares and Shapley as $+1^m.31$, (color class k3) (*These Publ.*, **30,** 192, 1918).

[3] The color index (Seares l. c.) is $+1^m.55$, corresponding to color class k9.

[4] This star has a high positive color index.

[5] Magnitude in C. D. $9^m.9$; not in C. P. D.; photographic magnitude $12^m.5$ according to Innes. (*Circ. Union Obs.* No. 48).

[6] Krüger 60 B; same effective wavelength as brighter component. (*Mt. Wilson Contr.* No. **101**).

A number of stars from Wolf's Catalogue in *Veröff. der Sternw. zu Heid.,* 7, 195, 1919, and his later lists published in the *Astronomische Nachrichten, i. e.,* the Nos. 1, 40, 47, 48, 53, 110, 125, 134, 156, 194, 219, 227, 1057, 261, 320, 338, 359, 362, 368, 373, 424, 429, 438, 457, 461, 489, 530, 534, 537, 586, 611, 612, 648, 692, 708, 716, 752, 804, 805, 830, 834, 842, 851, 860, 1062, 1129, 1069, 1084, 896, 1100, 918, 1106, 921, 923, 932, 940, 944, 945, 947, 990, 1023, 1216, 1040.

Also 13 additional stars, with the following positions and photographic magnitudes collected from various sources: $1^h6^m.0 - 72^\circ46'13^m.0$, $2^h4^m.0 - 67^\circ04'12^m.5$, $4^h6^m.5 - 53^\circ39'12^m.5$, $10^h46^m.4 + 14^\circ32'13^m.2$, $11^h40^m.2 - 64^\circ17'10^m.0$, $14^h8^m.8 - 13^\circ19'14^m.0$, $15^h32^m.0 - 54^\circ48'13^m.5$, $17^h4^m.7 - 76^\circ01'11^m.4$, $17^h11^m.2 - 75^\circ52'11^m.4$ (doubtful), $17^h38^m.2 - 57^\circ14'11^m$, $18^h43^m.7 - 59^\circ22'13^m.5$, $20^h59^m.8 - 11^\circ28'14^m$. $22^h31^m.4 - 65^\circ54'12^m.5$.

Thus we now have, together with the list published by Adams and Joy, 75 dwarf stars whose spectra are *known* to belong to class M, 23 stars with an absolute magnitude lower than $9^m.0$ and 76 stars with an estimated absolute magnitude below $10^m.5$, altogether 174 stars that are very probably M dwarfs.

With regard to Adams and Joy's list it may be mentioned, however, that according to them a few stars of Class K8 are included, and the two components of 61 *Cygni* might therefore be added (classified at Mt. Wilson as K7 and K8 respectively).

For Bo 18443 (Lal 47231) the Henry Draper spectrum for the combined light is K2, the Mt. Wilson spectrum for the brighter component K7 (there is hardly any difference in the magnitude though). A plate with simultaneous exposure of the two components was obtained by the writer and does not show any difference in spectral class, nor does it show the Titanium bands in the fainter star, and on the whole the spectrum resembles very much that of 61 *Cygni.* As the combined light corresponds to that of a star of $8^m.62$, according to Harvard, the magnitudes of the two components should be very near $9^m.3$ and $9^m.4$.

Nov. 10, 1922.

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